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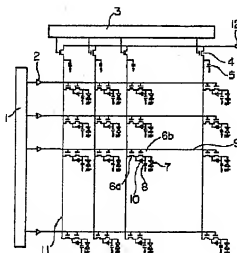
(54) LIQUID CRYSTAL DISPLAY DEVICE

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(57) Abstract:

PURPOSE: To obtain the liquid crystal display device having a satisfactory image quality by decreasing remarkably a leak current in a holding period of a switch element of a picture element part, and suppressing a potential variation of a picture element electrode caused by the leak current.

CONSTITUTION: In the liquid crystal display device constituted by forming a picture element part, a driving circuit part, a signal line 11 and a gate line 9 on a substrate, a switch element formed from at least two pieces of thin film MOS transistors 6a, 6b is connected between a picture element electrode for constituting the picture element part and the signal line 11, gate electrodes of at least two pieces of thin film MOS transistors 6a, 6b are connected to the same gate line 9, and between a connecting part of each of at least two pieces of thin film MOS transistors 6a, 6b and the picture element electrode, a buffer circuit 10 whose picture element electrode side is an input terminal is provided.



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- Notes:
- 1. Untranslatable words are replaced with asterisks (****).
 - 2. Texts in the figures are not translated and shown as it is.

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[Claim(s)]

[Claim 1] Two or more picture element parts formed on the same side of a substrate at matrix form, and the drive circuit section formed around said two or more picture element parts, In the liquid crystal display with which it comes to form the signal line which connects electrically said picture element part and said drive circuit section, and a gate line The switching device which constitutes said picture element part is formed from at least two thin film MOS transistors connected to the serial. Said switchin device is connected with the picture element electrode which constitutes said picture element part between said signal lines.

said -- at least -- [two gate electrodes of a thin film MOS transistor are connected to the same gate line, and] it connected with said serial -- at least -- Liquid crystal display characterized by having the buffer circuit which uses said picture element electrod side as an input terminal between two the connections of thin film MOS transistors and said picture element electrodes.

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the liquid crystal display with which especially the drive circuit section is really formed on the substrate by thin film transistors, such as polycrystalline silicon, about the liquid crystal display of the active matr used for the image display section, home television, etc. of OA equipment.

[0002]

[Description of the Prior Art] Since the conventional semiconductor manufacturing technology is applicable to that a big screen easy to be obtained and manufacture, many liquid crystal displays of the active matrix on the image display section, home television, etc. of OA equipment using a polycrystalline silicon thin film transistor are used. For this reason, improvement in the speed of the liquid crystal display of this method and high definition-ization are desired.

[0003] The representative circuit schematic of the liquid crystal display of the conventional active matrix which has the drive circuit section and a picture element part is shown in drawing 8 .

[0004] The drive circuit section consists of a vertical drive circuit and a level drive circuit by the CMOS circuit with a polycrystalline silicon thin film transistor. The vertical drive circuit consists of an analog switch 4 of the for a shift register 3 and for signal-line selection in a shift register 1 and the buffer 2 for gate actuation to a level drive circuit, and capacity 5 for signal potential maintenance.

[0005] A picture element part is a switching device about each pixel. It has the liquid crystal cell 7 and the storage capacitance used as the analog switch which connected two thin film transistors 6a and 6b to the serial, and a picture element electrode. In addition, 9 expresses a gate line, 11 expresses a signal line, and 12 expresses a signal input terminal.

[0006] [current driving capacity sufficiently big in order to operate a circuit with working speed required about the transistor of the drive circuit section] in the above-mentioned composition About the analog switch of a picture element part, the sufficiently big current driving capacity for charging the capacity of a picture element part at the time of ON and the sufficiently small OFF current for holding pixel potential at the time of OFF are needed.

[0007] [as a value of an OFF current, if the case of television of NTSC system is considered, for example, change with gradation numbers of a halftone display, but] For example, write-in period 1/60sec, pixel capacity As 0.2pF, about 1012ohms of OFF resistance of a switching device is needed, and a 10-12 A base is required also as an OFF current. In addition, although it changes with the actuation method, the property of liquid crystal and a thin film transistor, etc., even when loose conditions are considered, the voltage between a source and a drain the driving condition for driving the liquid crystal cell at this time 0-5V, and gate voltage It is necessary to move in the range which is -5 - 5 V grade.

[0008] An example of the current potential property of such a polycrystalline silicon thin film transistor is shown in drawing 7 . Channel width (W) to channel length's (L)'s ratio (W/L) drawing 7 10/10, and oxide layer thickness (tox) Drain voltage (VD) is made into a parameter about NMOS of 450 (angstrom). It is the experimental result in which the inventor etc. measured the gate voltage (VG) dependency of drain current (ID).

[0009] It compares with an amorphous silicon. 1-2 While ON current with expensive polycrystalline silicon with whenever [shift / high] is acquired, the leakage current which increases exponentially to gate voltage at the time of a gate reverse bias is seen. This leakage current seen by polycrystalline silicon is tunnel current which flows through the defective level in a crystal in the high electric field section near the drain, and by high mobility, when crystallinity is good, it is observed.

[0010] If the property of drawing 7 is seen, at the time of a gate reverse bias, the OFF current has crossed the 10-12 A base clearly. For example, drain voltage In 6.05 V, it is gate voltage. The OFF current has arrived at the 10-10A base in -5 V.

[0011] It is the amplitude of the signal level impressed to a signal line since the AC signal is required as a driving signal of liquid crystal. 10 V intensity is needed and it is also to the ends of a switching device. The potential difference of 10 V intensity will arise. This part Since an OFF current will far exceed an allowed value as mentioned above if you are going to make it take charge by one thin film transistor, it will become the picture with bad image quality with which the error by an OFF current was included in the gradation display.

[0012] In order to prevent this, at conventional parallel, it is a serial about a transistor. Two pieces connected and the method of reducing an OFF current is taken by making drain voltage of each transistor small.

[0013]

[Problem(s) to be Solved by the Invention] However, it is a serial about a transistor. It is drain voltage even if two pieces connect. It can reduce only to the half grade of one case, and has not become a fundamental solution. moreover, the number of transistors -- the increase more than three piece -- even if it carries out -- since gate voltage is common -- simple -- drain voltage One third effectiveness which becomes is not acquired -- compared with two cases, an OFF current has only the effectiveness which is the grade which becomes small a little. When the liquid crystal display was created using such a thin film transistor, the problem of image quality being unable to deteriorate, when pixel potential changes into the holding time, or it becoming impossible to display an image, when extreme had arisen.

[0014] [especially this invention / with the OFF current of the thin film transistor of the picture element part which becomes large when a reverse bias is impressed to the gate] Between the holding times needed, it is made in order to solve the problem that pixel potential cannot be held. The leakage current in the maintenance period of the switching device of a picture element part is decreased substantially, the electrical change of the picture element electrode by leakage current is suppressed, and it aims at offering a liquid crystal display with good image quality.

[0015]

[Means for Solving the Problem] Two or more picture element parts by which the liquid crystal display of this invention was formed on the same side of a substrate at matrix form, In the liquid crystal display with which it comes to form the signal line which connects electrically the drive circuit section formed around said two or more picture element parts, and said picture element part and said drive circuit section, and a gate line the switching device which constitutes said picture element part was connected to the serial -- at least -- [it is formed from two thin film MOS transistors, and] Said switching device is connected with the picture element electrode which constitutes said picture element part between said signal lines. said -- at least -- [two gate electrodes of a thin film MOS transistor are connected to the same gate line, and] it connected with said serial -- at least -- It is characterized by having the buffer circuit which uses said picture element electrode side as an input terminal between two the connections of thin film MOS transistors and said picture element electrodes.

[0016] [the buffer circuit which can be used for this invention] it connected with the serial which constitutes a switching device -- at least -- When two thin film MOS transistors will be in an OFF state, there is no limit in particular that what is necessary is just

the circuit which makes potential of the node of two thin film MOS transistors almost equal to the potential of a picture element electrode. In such a buffer circuit, the CMOS source follower circuit which combined the NMOS thin film transistor and the PMOS thin film transistor, a 2 steps of CMOS source follower circuit, or the voltage follower circuit using an operational amplifier (op amplifier) is located, for example. These are shown in drawing 6 from drawing 4.

[0017] if the CMOS source follower circuit shown in drawing 4 which combined the NMOS thin film transistor and the PMOS thin film transistor has the high threshold voltage of TFT -- between I/O voltage -- **** -- although slight offset voltage arises Structure is easy and is a suitable buffer circuit for the liquid crystal display of this invention.

[0018] moreover, **** produced between I/O voltage when the 2 steps of CMOS source follower circuit shown in drawing 5 has the high threshold voltage of TFT, although it becomes a little complicated [structure] -- slight offset voltage can be lessened further.

[0019] Furthermore, although it becomes more complicated [structure], the voltage follower circuit shown in drawing 6 using an op amplifier has a high current amplification factor, and it has the property whose linearity was good and which was excellent in it.

[0020] in this invention, the buffer circuit used the picture element electrode side as the input terminal, and was connected to the serial -- at least -- By using the connection of two thin film MOS transistors as an output terminal, potential of the node of thin film transistors and potential of a picture element electrode can be made almost equal.

[0021] In addition, the active layer of a thin film transistor has a desirable polycrystalline silicon film, and membrane formation of a polycrystalline silicon thin film is performed by the reduced pressure CVD method, the plasma-CVD method, a sputtering technique, etc. An amorphous (amorphous) silicon thin film is made to form without forming a polycrystalline silicon thin film from the beginning in that case. After carrying out the ion implantation of the method and silicon ion which perform and polycrystallized solid phase growth at about 600 degrees C, a semi-conductor thin film with big mobility can be obtained by using the method of carrying out solid phase growth etc. Although gate dielectric film uses the thermal oxidation film, the deposited film created with the ordinary pressure CVD method etc. can also be used. The gate electrode can use the polycrystalline silicon film which added and lower-resistance-ized the impurity. The formation of a source and a drain can perform a gate electrode after gate electrode formation by what active species is driven in for using a mask (selfer line system). An interlayer insulation film is formed with the oxide film by an ordinary pressure CVD method etc. after a source and drain formation, and they are formation of a contact hole, and aluminum. A source and a drain electrode can be formed by performing formation of the film, and a patterning.

[0022] In the liquid crystal display of this invention, the transparent conducting film used as a picture element electrode and a counter-electrode can use the ITO (Indium-Tin-Oxide) film, the tin oxide (SnO₂) film, etc.

[0023]

[Function] In the above-mentioned liquid crystal display, the OFF current of the thin film transistor of a picture element part where holding pixel potential can be made small enough.

[0024] That is, if a thin film transistor will be in an OFF state, the potential of the node of a thin film transistor will become almost equal to the potential of a picture element electrode by a buffer circuit. Therefore, since source potential and drain potential become almost equal about the thin film transistor by the side of a picture element electrode, an OFF current serves as a sufficiently small value from the buffer output point of two or more thin film transistors connected to the serial. Although big drain voltage is impressed about the thin film transistor of the preceding paragraph at this time and a big OFF current may flow The OFF current in this case is a current via a buffer circuit, and can be prevented from affecting the potential of a picture element electrode by constituting a buffer circuit from high input impedance circuits, such as a MOS circuit.

[0025] [when a thin film transistor is in ON state, commit a buffer circuit in the direction which checks the writing of the signal potential to a picture element electrode, but] on the other hand By making the impedance of a switching device small compare with the output impedance of a buffer circuit, or stopping operation of a buffer circuit in the ON state, about operation at the time of ON, cannot have effect and it can be carried out.

[0026]

[Example] Generally the representative circuit schematic shown in drawing 1 explains the liquid crystal display of this invention. A drive circuit is a CMOS circuit with a polycrystalline silicon thin film transistor, and the vertical drive circuit consists of an analog switch 4 of the for a shift register 3 and for signal-line selection in a shift register 1 and the buffer 2 for gate line driving transistor.

a level drive circuit, and capacity 5 for signal potential maintenance. a picture element part -- each pixel the analog switch by two NMOS thin film transistors 6a and 6b, the liquid crystal cell 7, and the storage capacitance 8 -- and -- It consists of a buffer circuit 10 inserted between two the nodes of the thin film transistors 6a and 6b and picture element electrodes.

[0027] Operation by the above-mentioned composition is explained below. A gate line is chosen with a shift register 1, the potential of the selected gate line is set to High level, and the potential of other gate lines is set to Low level. The video signal from the signal input terminal 12 is inputted into a signal line through the analog switch 4 chosen with the shift register 3. Since the potential of a video signal is set up between Low level and High level, the thin film transistor connected to the gate line 9 used as High level is set to ON, and a video signal is inputted into the liquid crystal cell 7 and the storage capacitance 8. [thin film transistor / which was connected to the gate line 9 set to Low level at this time] since the potential of the node of two thin film transistors is held by the buffer circuit 10 equipotential with a picture element electrode -- the source of a thin film transistor, and the potential difference between drains -- almost -- It is set to 0 and a good cut-off characteristic is obtained.

[0028] Next, the representative circuit schematic of the stroke matter of one example of the liquid crystal display by this invention is shown in drawing 2 . The buffer circuit 10 is a CMOS source follower circuit by the NMOS thin film transistor 14 and the PMOS thin film transistor 15, the power source by the side of plus is connected to the Cs line 13, and the power source by the side of minus is connected to the gate line 16 in front of one line. At this time, the Cs line 13 is set as the High level potential of a gate line. The NMOS thin film transistor 14 and the PMOS thin film transistor 15 of a buffer circuit are simultaneously manufactured in the same process as a drive circuit or the NMOS thin film transistors 6a and 6b for a switch. Therefore, although 14 and 15 become the transistor of an enhancement type and an output impedance becomes high, since the current level at the time of a cut-off is small enough if it is compared with on-level as shown in drawing 7 , it can be used as a buffer circuit. Moreover, at the time of the signal writing to a picture element electrode, the one as mentioned above where an output impedance is larger is convenient. The plan of the picture element part of one example of the liquid crystal display by this invention is shown in drawing 3 . It connected with the serial. Two NMOS thin film transistors 6a and 6b and the NMOS thin film transistor 14 of the buffer circuit 10, and the PMOS thin film transistor 15 have the top gate and coplanar structure. An active layer 18 is a polycrystalline silicon film.

[0029] Although gate dielectric film (not shown) uses the thermal oxidation film, the deposited film produced with the ordinary pressure CVD method etc. can also be used. The gate electrode (not shown) uses the polycrystalline silicon film which added and lower-resistance-ized the impurity. Formation of the source and the drain is performing the gate electrode after gate electrode formation by what active species is driven in for using a mask (self aryne method). An interlayer insulation film (not shown) is formed with the oxide film by an ordinary pressure CVD method etc. after a source and drain formation, and they are formation of a contact hole 19, and aluminum. The source and the drain electrode are formed by performing formation of the film 20, and patterning.

[0030] The storage capacitance 8 as well as a thin film transistor is formed by the MOS structure, and it uses as an MOS capacity by impressing bias voltage to the Cs line 13. The Cs line 13 is formed using the polycrystalline silicon film which added and lower-resistance-ized the impurity like the gate line. The picture element electrode 17 is a transparent electrode by ITO [Indium-Tin-Oxide], and forms a liquid crystal cell by enclosing liquid crystal between the counter substrates (not shown) which formed the transparent electrode similarly. A signal line 11 is aluminum. It is formed of the film.

[0031] As mentioned above, the liquid crystal display which can reduce the leakage current of a switching device substantially only by adding the CMOS buffer circuit 10 to the liquid crystal display by conventional parallel is realizable.

[0032]

[Effect of the Invention] The liquid crystal display by this invention is between a picture element electrode and a signal line. Two thin film MOS transistors are connected to the serial. it connected with this serial -- at least -- since it has the buffer circuit which uses the picture element electrode side as an input terminal between two the connections of thin film MOS transistors and picture element electrodes It becomes possible to decrease substantially the leakage current in the maintenance period of the switching device of a picture element part, the electrical change of the picture element electrode by leakage current is suppressed, and a liquid crystal display with good image quality is obtained.

[Brief Description of the Drawings]

[Drawing 1] It is one example of the liquid crystal display by this invention, and is drawing showing an equal circuit.

[Drawing 2] It is one example of the liquid crystal display by this invention, and is drawing showing the equal circuit of a picture element part.

[Drawing 3] It is one example of the liquid crystal display by this invention, and is drawing showing the top face of a picture element part.

[Drawing 4] It is drawing showing an example of the buffer circuit of the liquid crystal display by this invention.

[Drawing 5] It is drawing showing an example of the buffer circuit of the liquid crystal display by this invention.

[Drawing 6] It is drawing showing an example of the buffer circuit of the liquid crystal display by this invention.

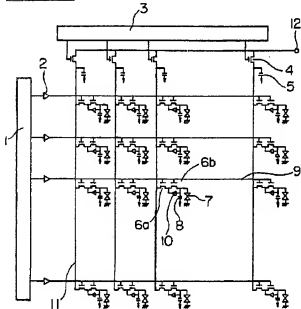
[Drawing 7] It is property drawing showing the gate voltage dependency of the drain current of the thin film transistor (NMOS, $W/L=10/10$ (micrometer), oxide layer thickness; $t_{ox}=450$ (angstrom)) used for the conventional liquid crystal display.

[Drawing 8] It is drawing showing the equal circuit of the liquid crystal display by conventional parallel.

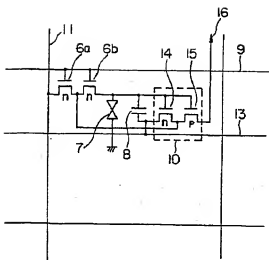
[Description of Notations]

1 A shift register, 2 A buffer, 3 Shift register, 4 An analog switch, 5 The capacity for signal potential maintenance, 6a, 6b Thin film transistor, 7 [..... Buffer circuit,] A liquid crystal cell, 8 Storage capacitance, 9 gate line, 10 11 [..... An NMOS thin film transistor, 15 / A PMOS thin film transistor, 16 / A gate line, 17 / A picture element electrode, 18 / An active layer, 19 / A contact hole, 20 / aluminum / Film.] A signal line, 12 A signal input terminal, 13 Cs line, 14

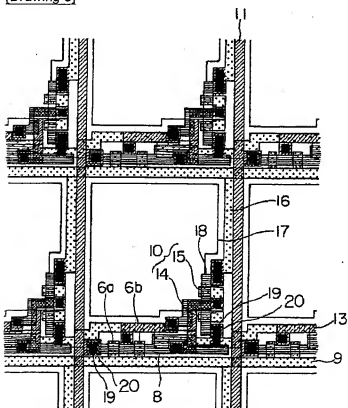
[Drawing 1]



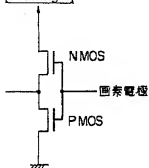
[Drawing 2]



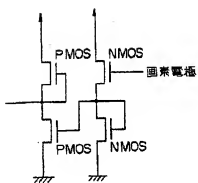
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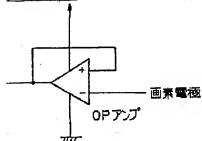
[Drawing 4]



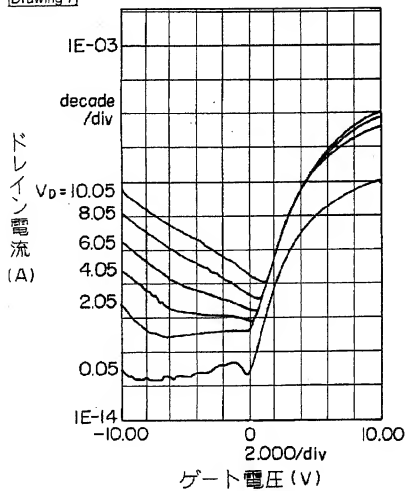
[Drawing 5]



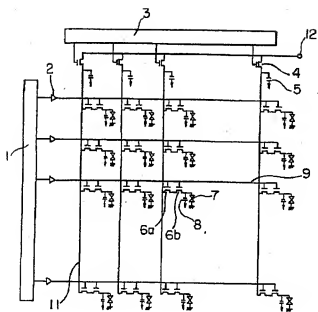
[Drawing 6]



[Drawing 7]



[Drawing 8]



[Translation done.]